ATTACHMENT 71111.21

INSPECTABLE AREA: Component Design Bases Inspection

INSPECTION BASES: Inspection of component design bases verifies the initial design and subsequent modifications and provides monitoring of the capability of the selected components and operator actions to perform their design bases functions. As plants age, their design bases may be difficult to determine and an important design feature may be altered or disabled during a modification. The plant risk assessment model assumes the capability of safety systems and components to perform their intended safety function successfully. This inspectable area verifies aspects of the Initiating Events, Mitigating Systems and Barrier Integrity cornerstones for which there are no indicators to measure performance.

LEVEL OF EFFORT: Biennially review 15-20 risk-significant and low design margin components, 3-5 relatively high risk operator actions and 4 - 6 operating experience issues.

71111.21-01 INSPECTION OBJECTIVE

To verify that design bases have been correctly implemented for the selected risk-significant components and that operating procedures and operator actions are consistent with design and licensing bases. This is to ensure that selected components are capable of performing their intended safety functions.

71111.21-02 INSPECTION REQUIREMENTS

02.01 Inspection Preparation

a. Inspection Schedule. This IP will be performed with a multi-disciplinary team consisting of contractors and NRC inspectors with expertise in power plant design and operation. The 7-week inspection schedule will consist of a pre-inspection site visit (preparation and sample selection), two weeks of in-office preparation, three weeks of on-site inspection, and one week of in-office documentation of inspection results.

b. Sample Selection. During the on-site pre-inspection visit and the first week of in-office preparation week, the team will select 15-20 risk-significant and low margin components and 3-5 risk-significant operator actions. In addition, the team will also select 4 - 6 risk-significant operating experience issues related to the selected components as well as generic or common cause issues that are not related to the selected samples for review. To the extent practical, the components selected should be grouped into discrete systems to allow for easier inspection; however, specific limits or boundaries should not be used during the sample selection process to limit the number of systems involved. The sample selection will be based on a risk-informed and low margin approach to identify the highly risk-significant components and operator actions at the facility. A senior reactor analyst and one of the site resident inspectors should participate during the component selection phase of the inspection to assist the team with the selection of inspection samples.

02.02 Detailed Component and Operator Action Engineering Review Requirements. For those components and operator actions identified as risk significant with low available margins, the team should review the following attributes for each inspection sample:

a. Detailed Design Review

The purpose of the design inspection is to verify that the selected components will function as required and support proper operation of the associated systems. In the process of reviewing the design, inspectors should verify the appropriateness of design assumptions, boundary conditions, and models. Independent calculations by the inspectors may be required to verify appropriateness of the licensee's analysis methods. The interfaces between safety related and non-safety related components should also be reviewed.

In reviewing the functional adequacy of the selected components, the inspectors should determine whether the design basis is met by the installed and tested configuration. The inspectors should understand not only the original purpose of the design but the manner and conditions under which the component will actually be required to function during transients and accidents. For example, if UFSAR information was used as inputs for design or procedures, these inputs should be verified to be consistent with the design bases.

Select a sample of inspection attributes for review and verify the design bases of selected components. Selection of inspection attributes should focus on those attributes that are not fully demonstrated by testing, have not received recent in-depth NRC review, or are critical for the component function. The table below, "Component Review Attributes," is a listing of example attributes that are needed for a component to perform its required function. The listing is not all inclusive and should be modified based on the selected components, as appropriate. During inspection preparation, identify which attributes are allocated to the selected components. Component design bases information for the selected components will have to be ascertained during the inspection preparation process.

Component Review Attributes	
Attributes	**Inspection Activity**
Process Medium • water • air • electrical signal	Verify that process medium will be available and unimpeded during accident/event conditions. • Example: For an auxiliary feedwater pump, verify that the alternate water source will be available under accident conditions. • Example: For emergency core cooling system piping, verify that the piping is kept free of voids as required by design bases or Technical Specifications.

Component Review Attributes	
Attributes	**Inspection Activity**
Energy Source • electricity • steam • fuel + air • air	Verify energy sources, including those used for control functions, will be available and adequate during accident/event conditions • Example: For a diesel driven auxiliary feedwater pump, verify that diesel fuel is sufficient for the duration of the accident. • Example: For an air-operated pressurizer PORV, verify that either sufficient reservoir air will exist or instrument air will be available to support feed and bleed operation. • Example: For a standby DC battery, verify adequacy of battery capacity.
Controls • initiation actions • control actions • shutdown actions	Verify component controls will be functional and provide desired control during accident/event conditions. • Example: For refueling water storage tank level instrumentation providing signal for suction swap-over to containment sump, verify that the setpoint established to ensure sufficient water inventory and prevent loss of required net positive suction head is acceptable.
Operator Actions • initiation • monitoring • control • shutdown	Verify operating procedures (normal, abnormal, or emergency) are consistent with operator actions for accident/event conditions. • Example: If accident analyses assume containment fan coolers are running in slow speed, verify that procedures include checking this requirement. • Example: If accident analyses assume that containment spray will be manually initiated within a certain time, verify that procedures ensure manual initiation within assumed time and that testing performed to validate the procedures was consistent with design basis assumptions. Verify instrumentation and alarms are available to operators for making necessary decisions. • Example: For swap-over from injection to recirculation, verify that alarms and level instrumentation provide operators with sufficient information to perform the task.
Heat Removal • cooling water • ventilation	Verify that heat will be adequately removed from major components • Example: For an emergency diesel generator, verify heat removal through service water will be sufficient for extended operation.

Verify that the component condition and tested capability is consistent with the design bases and is appropriate. The table below, “Component Condition and Capability,” is a listing of applicable attributes that could be inspected. Perform the inspection activities associated with the selected attributes.

Component Condition and Capability	
Attributes	**Inspection Activity**
Installed Configuration • elevations • flowpath components	Verify, by walkdown or other means, that components’ installed configuration will support its design basis function under accident/event conditions • Example: Verify level or pressure instrumentation installation is consistent with instrument setpoint calculations. Verify that component configurations have been maintained to be consistent with design assumptions.
Operation	Verify that component operation and alignments are consistent with design and licensing basis assumptions • Example: For containment spray system components, verify emergency operating procedure changes have not impacted design assumptions and requirements. • Example: For service water system components, verify flow balancing will ensure adequate heat transfer to support accident mitigation.
Design • calculations • procedures • plant modifications	Verify that design bases and design assumptions have been appropriately translated into design calculations and procedures. Also, verify that performance capability of selected components have not been degraded through modifications.
Testing • flowrate • pressure • temperature • voltage • current	Verify that acceptance criteria for tested parameters are supported by calculations or other engineering documents to ensure that design and licensing bases are met. • Example: Verify that flowrate acceptance criterion is correlated to the flowrate required under accident conditions with associated head losses, taking setpoint tolerances and instrument inaccuracies into account. Verify that individual tests and/or analyses validate component operation under accident/event conditions. • Example: Verify that EDG sequencer testing properly simulates accident conditions and the equipment response is in accordance with design requirements.

Attributes	Inspection Activity
Component Degradation	Verify that potential degradation is monitored or prevented. • Example: For ice condensers, verify that inspection activities ensure air channels have been maintained consistent with design assumptions. Verify that component replacement is consistent with inservice/equipment qualification life. Verify that the numbers of cycles are appropriately tracked for operating cycle sensitive components.
Equipment/ Environmental Qualification • Temperature • Humidity • Radiation • Pressure • Voltage • Vibration	Verify that equipment qualification is suitable for the environment expected under all conditions. • Example: Verify equipment is qualified for room temperatures under accident conditions.
Equipment Protection • fire • flood • missile • high energy line break • HVAC • freezing	Verify equipment is adequately protected. • Example: Verify freeze protection adequate for CST level instrumentation. • Example: Verify that conditions and modifications identified by the licensee's high energy line break analysis have been implemented to protect selected highly risk-significant components.
Component Inputs/Outputs	Verify that component inputs and outputs are suitable for application and will be acceptable under accident/event conditions. • Example: Verify that valve fails in the safe configuration. • Example: Verify that required inputs to components, such as coolant flow, electrical voltage, and control air necessary for proper component operation are provided.
Operating Experience	Verify that applicable insights from operating experience have been applied to the selected components. • Example: Verify that component functioned appropriately when challenged during transients.

b. Equipment Reliability Review and Walkdown of Selected Components

1. Review any outstanding repetitive maintenance work requests on the selected components and any deficiencies that could affect the ability of the components to perform its function(s).

2. Review any outstanding design issues, including open/deferred or canceled engineering action items, temporary modifications, operator workarounds, and items that are tracked by the operations or engineering departments that may affect selected highly risk-significant components.

3. Perform a walkdown inspection of the selected components. Identify any discrepancies between the existing equipment alignment and the correct alignment. Inspect for visible signs of deficient conditions such as corrosion, missing fasteners, cracks, degraded insulation, etc. During the walkdown of the selected components, inspectors should consider the following questions:

   (a). Is the installed component consistent with the piping and instrument diagram?

   (b). Will equipment and instrumentation elevations support the design function?

   (c). Has adequate sloping of piping and instrument tubing been provided?

   (d). Are required equipment protection barriers (such as walls) and systems (such as freeze protection) in place and intact?

   (e). Does the location of the equipment make it susceptible to flooding, fire, high energy line breaks, or other environmental concerns?

   (f). Has adequate physical separation/electrical isolation been provided?

   (g). Are there any non-seismic structures or components surrounding the components which require evaluation for impact upon the selected component?

   (h). Does the location of equipment facilitate manual operator action, if required?

   (i). Are baseplates, hangers, supports and struts installed properly?

   (j). Are there indications of degradations of equipment ?

   (k). Are the motor-operated valve operators and check valves (particularly lift check valves) installed in the orientation required by the manufacturer?

4. Technical Evaluations/Corrective Action Program Review

For each low margin, risk-significant component within the sample selection, the inspectors should review all associated significant corrective action documents generated within the last four years including any degraded or deficient conditions that have not been entered into the corrective action program. Review the adequacy of any licensee technical evaluation (corrective action program evaluations, engineering evaluations, operability determinations, etc.) associated with the component, and determine if operability is justified and problems are properly identified and corrected. Verify that the licensee considered other degraded conditions and their impact on compensatory measures for the condition being evaluated. See Inspection Procedure 71152, "Identification and Resolution of Problems," for additional guidance on corrective actions.

If operability is justified, no further review is required. If the operability evaluation involves compensatory measures, determine if the measures are in place, will work as intended, and are appropriately controlled. If operability is not justified determine impact on any Technical Specification LCOs. Refer to Part 9900 Technical Guidance, STSODP, "Operability Determinations & Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety," for additional information.

c. Review of Operating Procedures and Operator Actions

For the selected components and operator actions, walk-through a sample of associated system operating procedures at the functional level with an appropriate plant operator. This includes normal, abnormal, and emergency operating procedures. For the sample of procedures selected for review, verify that the procedures are consistent with engineering inputs and assumptions and the operators are able to implement the procedures from the main control panel and the alternate shutdown or local control panels and the key components and equipment are accessible for normal and emergency operation. If any special equipment is required to perform these procedures, determine if the equipment is available and in good working order. Verify that the knowledge level of the operators is adequate concerning equipment location and operation.

The inspectors should consider the following attributes to verify the adequacy of the operating procedures to support the design and verify that key operator actions can be performed within the constraints of the design analyses.

- the specific operator actions required;
- the potentially harsh or inhospitable environmental conditions expected;
- a general discussion of the ingress/egress paths taken by the operators to accomplish functions;
- the procedural guidance for required actions;

- the specific operator training necessary to carry out actions, including any operator qualifications required to carry out actions;

- any additional support personnel and/or equipment required by the operator to carry out actions;

- a description of information required by the control room staff to determine whether such operator action is required, including qualified instrumentation used to diagnose the situation and to verify that the required action has successfully been taken;

- the ability to recover from credible errors in performance of manual actions, and the expected time required to make such a recovery;

- consideration of the risk significance of the proposed operator actions;

- the time available to complete an action based on safety analyses and the methods used by the license to verify and validate that the required actions can be completed within the available time. This review area should include a field walkdown to validate the licensee's timing assumptions. Particular attention should be given to time dependent actions that must be accomplished outside the control room by auxiliary equipment operators; and

- observe demonstrations or training in the simulator that validate operator actions for a given event or accident condition.

d. Permanent Plant Modification Review

For the selected components, the team should review a sample of applicable permanent plant modifications to verify that the design bases, licensing bases, and performance capability of selected components have not been degraded through modifications.

1. Design Review

   (a). Review the design adequacy of the modification by performing the activities identified in Section 02.02.a. Refer to IP 71111.17, "Permanent Plant Modifications," for more information.

   (b). Verify that the licensee has considered the conditions under which they may make changes to the facility or procedures or conduct tests or experiments without prior NRC approval. Verify that the licensee has appropriately concluded that the change, test or experiment can be accomplished without obtaining a license amendment. For the changes, tests, or experiments that the licensee determined that evaluations were not required, verify that the licensee's conclusions were correct and consistent with 10 CFR 50.59. Refer to IP 71111.02, "Evaluation of Changes, Tests, or Experiments," for more information.

2. Post-modification Testing Review.

Verify that post-modification testing will establish operability by:

- Verifying that unintended system interactions will not occur.

- Verifying SSC performance characteristics, which could have been affected by the modification, meet the design bases.

- Validating the appropriateness of modification design assumptions.

- Demonstrating that the modification test acceptance criteria have been met.

02.03 Operating Experience Review. The team will select 4 - 6 operating experience issues related to the selected components as well as generic or common cause issues that are not related to the selected samples for review. Some of the operating experience selected should cover initiating events and barrier integrity cornerstones. For the operating experience items selected for review, the team should assess how the licensee evaluated and dispositioned each item. The focus should be on ensuring that the conditions discussed in the operating experience either are not applicable, or have been adequately addressed by the licensee to ensure operability of the component. To the extent practical, the inspectors should acquire objective evidence that the operating experience item has been resolved, beyond a written licensee evaluation. For example, if the operating experience item required a procedure change, the inspector should verify the procedure was changed. If the operating experience required modification of a component, the inspector should verify the modification was completed.

71111.21-03 INSPECTION GUIDANCE

03.01 General Guidance on System and Component Selection

a. Inspection Schedule. A typical team inspection time line is expected to consist of the following:

Week 1 On-site preparation/sample selection.

Week 2 In-office preparation/finalizing samples for inspection.

Week 3 On-site inspection of selected samples.

Week 4 In-office preparation/inspection activities.

Week 5 On-site inspection of selected samples.

Week 6 Last week of on-site inspection of selected samples.

Week 7 Documentation of inspection results.

Note: Regions may rearrange the order of on-site inspection and preparation weeks as long as the direct inspection and contractor support efforts are not exceeded. The team leader would require additional time to prepare for the inspection and after the inspection to integrate the report input.

b. Team Staffing and Administration. The design review portion of the inspection should be performed by inspectors with extensive nuclear plant design experience, preferably comparable to the experience gained through previous employment with an architect engineering firm. The team composition will be an NRC team leader, two design specialists in the mechanical and electrical or instrumentation and control disciplines (typically contractors), two regional inspectors (operations and engineering). In addition, as a minimum, a senior reactor analyst and one of the resident inspectors should participate during the component selection phase of the inspection to assist the team with the selection of inspection samples. If possible, the regional branch chiefs should assign Nuclear Safety Professional Development Program participants or inspector trainees for developmental or qualification training purposes.

c. Sample Selection. The team will visit the selected site during the preparation phase to facilitate sample selection based on risk significance and the least available margin. Margin is typically defined as the difference between the actual (or predicted) and required performance of a system, component, operator action. Low margin can be a function of the original design, caused by design modifications, or can be due to degraded material conditions. Inspection samples (safety or non-safety risk-significant components) should be identified at the major component (e.g. pump, motor operated valve, etc.) or procedural step level to assist in inspection planning. Included within the sample selected should be passive components such as sump screens, strainers, piping, cables, etc., whose failure could impact system functionality, component design function that involves a lot of operation and human actions, availability/reliability issues, and component design attributes which are not fully demonstrated through testing. To the extent practical, the sample should include a diverse range of equipment and human actions.

The team leader and the Senior Reactor Analyst (SRA) should develop an approach for identifying the most critical components and operator actions at the selected facility. Although the methods used to identify the highly risk-significant components and operator actions will be dependent on the type and quality of the licensee's risk assessment tools, the following criteria should be considered:

- Risk Reduction Worth (RRW): The RRW is the factor by which the plant's core damage frequency decreases if the component or operator action is assumed to be successful. Components or operator actions with a RRW value of 1.005 or greater should be considered for inclusion in the inspection sample. A lower threshold may be used if desired.

- Risk Achievement Worth (RAW): The RAW is the factor by which the plant's core damage frequency increases if the component or operator action of interest is assumed to fail. Components and actions with a RAW value of 2 or greater should be considered for inclusion within the inspection sample. A lower threshold may be used if desired.

- Delta CDF or Delta LERF Data: Components or operator actions which increase the delta CDF or delta LERF by an order of magnitude should be considered for inclusion within the inspection sample. Likewise, components or actions that increase the initiating event likelihood by an order of magnitude should also be considered (e.g. service water system). For Delta LERF as an example, in plants with ice condenser containment designs certain accident sequences (e.g. station blackout) result in a dominant risk increase from Delta LERF versus Delta CDF. These sequences can be found by looking in the "LERF Factor" column of the plant's pre-solved phase 2 SDP notebook. Contact the Division of Risk Assessment of NRR for this information.

- Subjective risk rankings based on engineering or expert panel judgement such as those performed to identify risk significant structures, systems, and components for the licensee's Maintenance Rule program. These subjective risk rankings typically are performed to establish the risk significance of equipment that may not be fully modeled in the licensee's probabilistic risk assessment.

- The use of dominant accident sequences in PRAs to select components may be appropriate for SSCs that are more significant to LERF than CDF; external events (e.g., fire, seismic, flood) than internal events (e.g., LOCAs); or risk during shutdown than during normal operation.

- Other risk criteria established by the team leader and SRA (e.g. operating experience, engineering judgment, etc.).

In identifying specific inspection areas for the margin review, the team should broadly assess component and operator attributes necessary to meet the probabilistic risk assessment functional success criteria. For example, if the sample selection review identifies a specific pump failure to start or run as risk-significant, margin review activities should consider all conditions that could reasonably cause loss of pump flow (e.g. clogged suction strainer, loss of motive power, inadequate net positive suction head, valve misalignment or failure, etc.). The following activities should be performed to identify low margin areas:

- Design and engineering specialists should review detailed calculations associated with the identified risk-significant components to identify areas of low margin. In this case, the inspector should identify calculations showing little margin between predicted results and calculation and/or regulatory acceptance criteria.

- Inspectors should obtain corrective action program insights and a repetitive maintenance summary associated with the identified risk-significant components.

- Inspectors should review operating procedures, and operator task analysis validation studies to identify critical operator actions with little margin between the time required and the time available to complete an action.

The margin review should include evaluation of the impact of plant modifications or licensing basis changes on available margin. In particular, licensing changes that can reduce safety analysis margins, such as extended power uprates, should be considered.

d. Sources of Information. The following table shows the suggested sources of information necessary to perform this inspection.

Information	Suggested Sources
Design Bases	Updated Final Safety Analysis Report (UFSAR) Design Basis Documentation System Descriptions Design Calculations Design Analyses Piping & Instrumentation Drawings Significant Design Drawings Significant Surveillance Procedures Pre-operational Test Documents Vendor Manuals
Licensing Bases	NRC Regulations Plant Technical Specifications UFSAR NRC Safety Evaluation Reports
Applicable Accidents/Events	UFSAR Individual Plant Examination PRA analyses Emergency Operating Procedures (EOPs)
System Changes	System Modification Packages (including post modification test documents) 10 CFR 50.59 Safety Evaluations Temporary Modifications Work Requests Setpoint Changes EOP Changes
Industry Experience	Licensee Event Reports Bulletins Generic Letters Information Notices

Information	Suggested Sources
PRA Information	Individual Plant Examinations (IPE) or Updated PRA model results Risk-informed inspection notebooks Risk importance rankings for SSCs Dominant accident sequences Important operator actions Individual Plant Examinations for External Events

03.02 General Design Inspection Guidance

Design Review. The purpose of the design inspection is to verify that the components will function as required and support the proper operation of the associated systems. In the process of reviewing the design, inspectors should verify the appropriateness of design assumptions, boundary conditions, and models. Independent calculations by the inspectors may be required to verify appropriateness of the licensee's analysis methods.

In reviewing the functional adequacy of the selected components, the inspectors should determine whether the design basis is met by the installed and tested configuration. The inspectors should understand not only the original purpose of the design but the manner and conditions under which the system will actually be required to function during transients and accidents. For example, if UFSAR information was used as inputs for design or procedures, these inputs should be verified to be consistent with the design bases.

During the design review, inspectors should consider the following questions:

Valves

1. Are the permissive interlocks appropriate?

2. Will the valve function at the pressures and differential pressures that will exist during transient/accident conditions?

3. Will the control and indication power supply be adequate for system function?

4. Is the control logic consistent with the system functional requirements?

6. What manual actions are required to back up and/or correct a degraded function?

Pumps

7. Is the pump capable of supplying required flow at required pressures under transient/accident conditions?

8. Is adequate net positive suction head (NPSH) available under all operating conditions?

9 Is the permissive interlock and control logic appropriate for the system function?

10. Is the pump control adequately designed for automatic operation?

11. When manual control is required, do the operating procedures appropriately describe necessary operator actions?

12. What manual actions are required to back up and/or correct a degraded function?

13. Has the motive power required for the pump during transient/accident conditions been correctly estimated and included in the normal and emergency power supplies?

14. Do vendor data and specifications support sustained operations at low flow rates?

15. Is the design and quality of bearing and seal cooling systems acceptable?

Instrumentation

16. Are the required plant parameters used as inputs to the initiation and control system?

17. If operator intervention is required in certain scenarios, have appropriate alarms and indications been provided?

18. Are the range, accuracy, and setpoint of instrumentation adequate?

19. Are the specified surveillance and calibrations of such instrumentation acceptable?

Circuit Breakers and Fuses

20. Is the breaker control logic adequate to fulfill the functional requirements?

21. Is the short circuit rating in accordance with the short circuit duty?

22. Are the breakers and fuses properly rated for the load current capability?

23. Are breakers and fuses properly rated for DC operation?

Cables

24. Are cables rated to handle full load at the environmental temperature expected?

25. Are cables properly rated for short circuit capability?

26. Are cables properly rated for voltage requirements for the loads?

Electrical Loads

27. Have electrical loads been analyzed to function properly under the expected lowest and highest voltage conditions?

28. Have loads been analyzed for their inrush and full load currents?

29. Have loads been analyzed for their electrical protection requirements?

As-built System

30. Are service water flow capacities sufficient with the minimum number of pumps available under accident conditions?

31. Have modified equipment components falling under the scope of 10 CFR 50.49 been thoroughly evaluated for environmental equipment qualification considerations such as temperature, radiation, and humidity?

32. Are the modifications to the system consistent with the original design and licensing bases?

Specific Guidance

No specific guidance provided.

71111.21-04 RESOURCE ESTIMATE

This inspection procedure is estimated to take an average of 680 hours (408 NRC inspector hours and 272 contractor support hours) based on a team of five inspectors at a site.

71111.21-05 COMPLETION STATUS

Inspection of the minimum sample size will constitute completion of this procedure in the RPS. That minimum sample size consists of 15 component reviews, three operator actions and four operating experience issues, regardless of the number of units at the site.

71111.21-06 REFERENCES

1. IP 71111.04, “Equipment Alignment.”
2. IP 71111.15, “Operability Evaluations.”
3. IP 71111.17, “Permanent Plant Modifications.”
4. IP71111.02, “Evaluation of Changes, Tests, or Experiments.”
5. IP 71111.22, “Surveillance Testing.”
6. IP 71152, “Identification and Resolution of Problems.”
7. IP 93801, “Safety System Functional Inspection (SSFI).”
8. Information Notice 97-078, “Crediting of Operator Actions in Place of Automatic Actions and Modifications of Operator Actions, Including Response Times.”
9. SECY-04-0071, dated April 29, 2004 (ML040970328).
10. SECY-05-0118, dated July 1, 2005 (ML051390465).

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